



by James Brodrick

**In a world still geared toward incandescent, some guidance for dimming LEDs with existing phase-cut dimmers**

**B**y now, solid-state lighting (SSL) has a proven track record for delivering equivalent lighting performance with improved energy efficiency compared to most halogen, compact fluorescent and high-intensity discharge lighting systems. But one significant barrier to SSL's market adoption has been its often-poor performance with existing dimming-control systems. LEDs themselves are inherently dimmable, but not necessarily with every driver, and not with every dimmer. Although some LED light sources are as smooth-dimming as incandescent lamps, others can exhibit a wide range of bewildering and less-than-desirable dimming behavior—from dimming erratically, to shifting in color as they dim, to having a very limited dimming range, to producing flicker or noise, to producing no light at all, to simply not dimming.

The industry has been addressing this issue in various ways. For example, some retailers are attempting to position the right wall-box dimmers next to LED lighting products for use in residential and small commercial applications. And last year, the National Electrical Manufacturers Association (NEMA) published SSL-7A, "Phase Cut Dimming for Solid State Lighting: Basic Compatibility," which contains a set of design specifications intended to ensure that one or more compliant LED light engines will work well with compliant dimmers.

But SSL-7A is intended to be used to design and qualify dimmer and light-engine products for use with each other, not to determine compatibility with existing products. So the compliance of a dimmer or light engine

with SSL-7A doesn't predict performance with noncompliant products. Furthermore, SSL-7A does not address larger architectural dimming products and applications.

In the absence of a clear-cut solution to the dimming problem, the U.S. Department of Energy (DOE) recently published a report that provides some guidance. *Dimming LEDs with Phase-Cut Dimmers: The Specifier's Process for Maximizing Success* is based on experience from CALiPER testing and Gateway demonstrations and is available online at [www.ssl.energy.gov/gatewaydemos\\_results.html](http://www.ssl.energy.gov/gatewaydemos_results.html).

There are several different dimming techniques in use for lighting, including DALI, 0-10V, DMX and other techniques that separate the dimming signal from the AC mains voltage provided to the light source. The majority of the installed base of dimming systems, however, uses phase-control techniques to dim incandescent lamps, which they were designed to work with. The new report focuses on phase-cut dimmers, reviewing how they work and how differences between LEDs and incandescent lamps can lead to complications when trying to dim LEDs. Despite progress in the dimming of LED luminaires using carefully matched dimming systems, challenges remain with compatibility and performance of LED replacement lamps and luminaires on existing phase-cut dimming systems.

## A QUESTION OF COMPATIBILITY

Such problems are usually due to incompatibility between the LED source and the phase-cut dimmer rather than due to any shortcoming in the LED product itself. Compatibility between a specific LED source and a specific phase-cut



Photo courtesy George Gruel, Oddstick Studio

**Computer-rendered visualization of the completed interior of the Burden Museum.**



Photo: Randall Perry Photography, Schaghticoke, NY

**View of a Hudson River Valley worship space, showing track mounted to beams with halogen MR16 track heads. The church would like to relamp with LED MR16s.**

dimmer is often unknown and difficult to assess, and ensuring it can add complexity to the design, specification, bidding, and construction observation phases for new buildings and major remodel projects. In existing buildings, where LED lamps are replacing installed incandescent or halo-

gen lamps for energy savings and longer life, it's necessary to determine whether a specific make and model of LED lamp will meet expectations when controlled by the installed dimming system.

The report offers general guidance and outlines step-by-step procedures for

designing phase-controlled LED dimming on new and existing projects. It also offers real-world examples of how to use those procedures, focusing on a Gateway demonstration where LEDs and a new lighting control system are being specified for use in the Burden Museum in Troy, NY; and a project where halogen MR16 and PAR38 lamps controlled by an architectural dimming system are being retrofitted with LED lamps at a church in New York's Hudson River Valley. Because these projects are still in construction, results are not yet available. But they illustrate the process for evaluating LED lighting products in conjunction with phase-cut dimmers.

## SOME GENERAL GUIDELINES

The report's general guidance—which is summarized here in rough order of decreasing confidence—is intended to reduce the likelihood of experiencing compatibility-related problems:

- Perform a full mock-up of every lighting circuit, including all LED sources and dimming controls, and test over the full dimming range.
- If a mock-up isn't possible, use a proven combination of LED sources and dimmer, but make sure the information is less than six months old, or it may already be outdated.
- For wall-box installations, specify a NEMA SSL-7A-compliant dimmer and compliant LED sources, to guarantee a level of compatibility and ensure that the dimmer will not negate the dimming claims of the lamp or luminaire.
- Specify a combination of LED sources and dimming control recommended by the LED source or dimming-control

manufacturer—or, ideally, by both.

- Specify a three-wire dimmer and derate the capacity of the dimmer. This eliminates most dimmer-caused compatibility issues but doesn't ensure good-quality dimming, which is limited by the inherent capabilities of the LED source.
- Specify a phase-control type (e.g., forward-phase, or reverse-phase) recommended by the LED source manufacturer, and derate the capacity of the dimmer. This should eliminate some dimmer-caused compatibility issues. The acceptability of the LED source performance in this case is purely based on manufacturer judgment of the dimming quality.

Excellent dimming is also available using other kinds of dimming approaches. These, too, are not without issues and tend to cost more than phase-cut dimming, but overall they may result in better performance with SSL products. However, it should be noted that some LED lighting products are already showing significant improvement in dimming, and this should only get better over time. For now, though, the DOE report (at [www.ssl.energy.gov/gatewaydemos\\_results.html](http://www.ssl.energy.gov/gatewaydemos_results.html)) can serve as a useful reference.

*James Brodrick is the lighting program manager for the U.S. Department of Energy, Building Technologies Office.*